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ABSTRACT

Arguing that the seller of creative works--including audio and video productions and computer software--will be affected by the ability of consumers to make high quality copies of these works, this paper examines the theoretical effects of copying on the sellers of originals and speculates about ways to estimate these effects empirically. The paper begins with a discussion of consumer copying behavior which summarizes the effects that raise the demand for originals (i.e., stimulation of hardware purchases, network externalities, and purchase of originals to make copies), and discusses the effects of demand on the cost of copies. A strategy for estimating the effects of copying on the producers of originals is then outlined, and a brief discussion of the effects of copying on the price of originals concludes the paper. Six figures illustrate the text and two references are provided. (EW)

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The Effect of Copying on the Producers of Originals

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Abstract:

Sellers of creative works (audio and video productions, computer software) will be affected by the ability of consumers to make high quality copies of these works. This paper looks at how sellers might be affected and concludes that sellers' profits may either rise or fall with copying. A strategy for estimating the effect of copying on sellers is also outlined.

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The Effect of Copying on Producers of Originals

William R. Johnson, University of Virginia

I. Introduction

When consumers can produce their own versions of creative works (hereafter called originals), the market for those originals will be affected. Recent technological advances have allowed consumers to copy broadcast or recorded music onto audio cassettes, to copy broadcast or recorded visual performances onto to video cassettes, and to make copies of computer software. The advent of digital audio tape (DAT) will allow consumers to make even higher quality copies of recorded originals. These technical advances have caused concern, to say the least, among the sellers of originals and legislation designed to impede the ability of consumers to make copies has been routinely proposed and supported by these sellers.

My purpose in this paper is not to examine the "big" question of whether restrictions on home copying are warranted but rather to provide a theoretical framework for analyzing the smaller but still important question of the effects of copying on the sellers of originals. Most of the paper is devoted to an examination of the theoretical effects of copying in these markets, but at the end of the paper, I speculate about ways to estimate these effects empirically.

II. Consumer Copying Behavior

Copies differ from originals in both quality and cost. The quality of copies may be superior to originals (as is often alleged with respect to home

recorded audio and video tapes compared with commercially prerecorded tapes) or inferior to originals (as when copies of computer software do not include the user support that software firms provide to those who buy originals). For the rest of the paper, however, I want to disregard quality differences and concentrate on cost differences between copies and originals. The cost of acquiring an original is relatively easy to compute: the purchase price plus the time involved in choosing and buying it. The cost of acquiring a copy is more difficult to compute because, with a few exceptions, there are not organized markets for copies. Consumers typically produce their own copies by finding an original and then using some durable good (like a tape recorder or VCR) to make a copy. The cost of acquiring a copy probably includes a substantial amount of consumer time. Why do some consumers copy and some not ?[1] One answer is that since the time involved in copying is likely to exceed the time required to purchase an original, consumers with high values of time will be less likely to copy. Another answer is that copying requires specialized equipment which people invest in only if they anticipate making many copies.[2]

How does the possibility of copying affect the demand for originals? We first summarize those effects which raise the demand for originals:

1. Stimulation of Hardware Purchases: The possibility of copying raises the value of investing in hardware (tape decks, video recorders, computers); since hardware is necessary to enjoy the software (cassette tapes, video tapes, computer programs), the market for originals is broadened.

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[1] I explore these reasons in more detail in my 1985 paper.

[2]The fact that we do not observe many "play-only" VCRs or audio tape recorders is testimony to the value consumers place on being able to record. The demise of the video disk technology is also attributed to the lask of recording capability on those machines.

2. Network externalities: The value of owning software may depend on the number of other owners of software, so that copying would raise the value of originals. This would seem to be most true for computer software where learning about software from others is important.

3. Purchase of originals to make copies: Since an original is needed to make a copy, the value of an original is raised by the possibility of copying. Informal social networks in which originals are exchanged to make copies may substitute for a formal rental market for originals. Each member of the network must invest in some originals of his own to gain access to the other members' originals .

The negative effect of copying on the purchase of originals is obvious: copying substitutes for buying originals. The possibility of copying may also affect the price at which originals sell by altering the demand curve facing the producers of originals. As we shall see, measuring the loss to sellers of originals at the prices charged with copying understates the total loss since in the absence of copying, prices could be changed (either up or down) to increase seller revenue.

To illustrate the effect of copying on the demand for originals, I consider a seller of originals who faces a linear demand for his product as a function of its price, p_o:

(1) $$Q_o = a - bp_o.$$

As a profit-maximizing monopolist[3], this seller will choose a price at which marginal revenue equals marginal cost, which assuming a constant marginal

[3] The seller has monopoly power because his creative work is different from other creative works.

cost, c, will be equal to $(c + a/b)/2$. It is easy to compute that the firm's profits are equal to $(a - cb)^2/4b$. Figure 1 illustrates this standard situation.

Cost of Copying is a Fraction of Price of Originals

Now let us assume that consumers can make copies, which they deem to be equivalent to originals in quality. For simplicity, assume that an original is required for each n copies made.[4] This is intended to represent the fact that originals are required, at some point, to make copies and that while there may be no technological limit to the number of copies that can be made from one original, there is an economic limit due to the time and trouble involved in tracking down the original.[5] Simplifying drastically, the cost of a copy will then be p_o/n, the one copy's share of the cost of acquiring an original. Now originals will be purchased only for their ability to make copies. The demand for originals will be Q_c/n, where Q_c is the number of copies made.

How many copies will be made ? Since copies are perfect substitutes for originals, the demand curve for copies is the same as the demand for originals:

$$Q_c = a - b(p_o/n). \tag{2}$$

Therefore, the demand for originals, valued now only because they can be used to make copies, is :

$$Q_o = [a - b(p_o/n)]/n. \tag{3}$$

The effect of copying on the demand curve for originals is shown in Figure 2. As is clear, demand is increased at high prices and reduced at low prices. At

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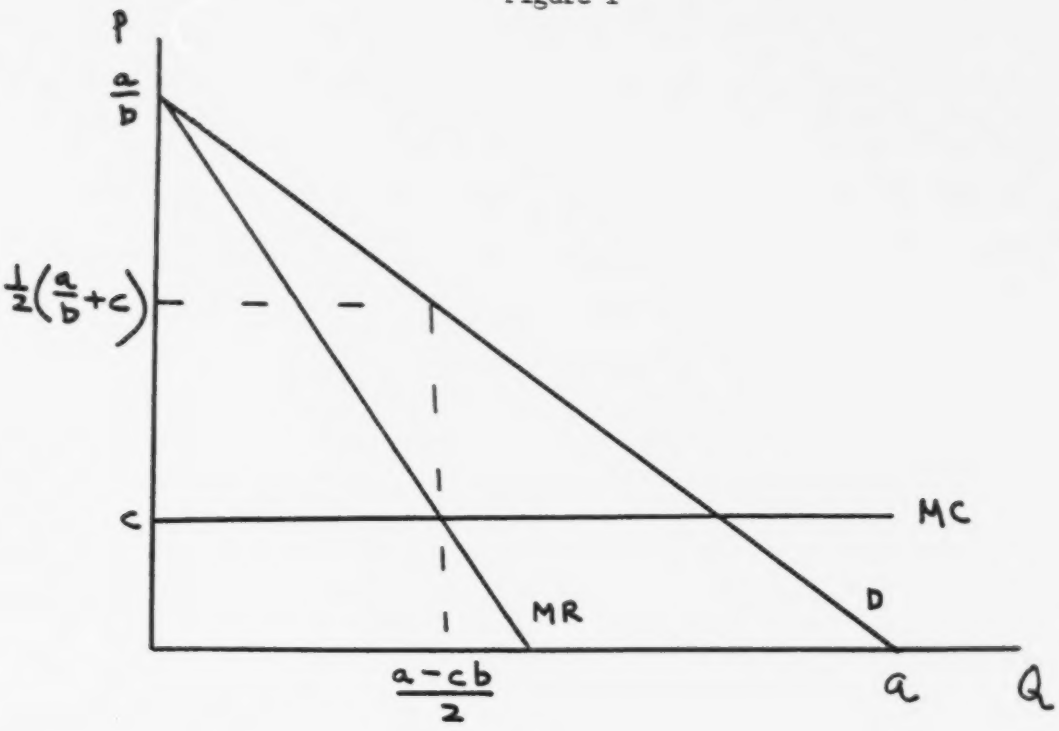
[4] The analysis here closely follows Besen (1984).

[5] While it is true that one original could be used to make a very large number of copies, suppose that original were in New York and you were in Los Angeles. The cost of procuring that one original to make a copy would not be worth it.

Figure 1



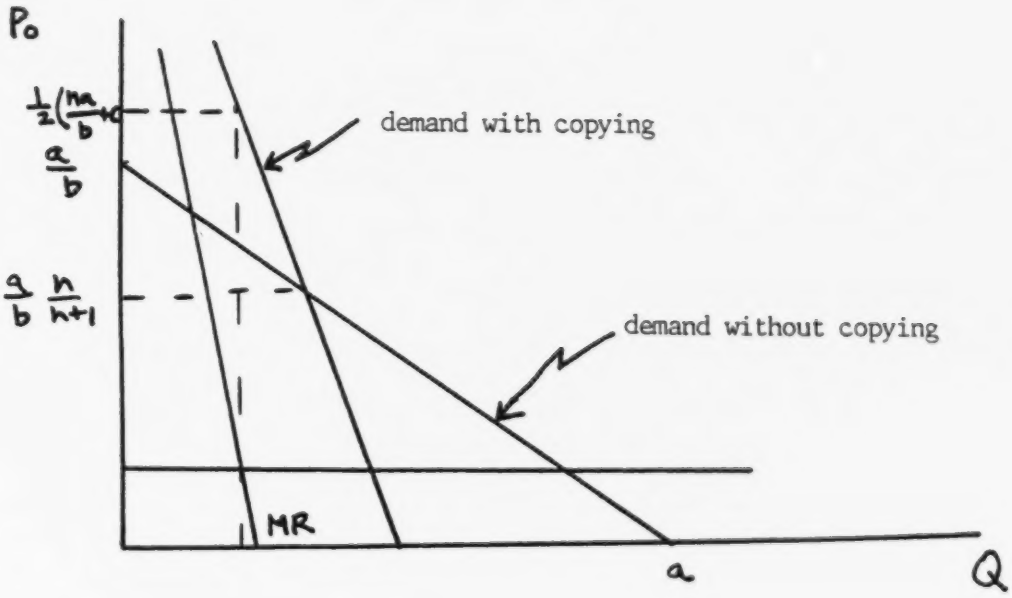


Figure 2

high prices, the demand inducement effect dominates while at low prices, the substitution effect dominates.

The intuition behind these changes in the demand curve comes from considering the elasticity of demand. At any price of originals, p_o, copying reduces the cost of obtaining a copy to p_o/n, which stimulates the demand for copies. At the same time, the demand for originals which are now valued only because they can make copies, falls to one n^{th} of the demand for copies. Thus, the demand for originals will rise (at the same price) only if the demand for copies is more than n times the demand for originals in the absence of copying. Since the cost of a copy is one n^{th} of the price of an original, demand for copies will rise more than n-fold only if demand is elastic.[6] So whenever demand is elastic in this simple view of copying, demand will rise. Since the simple theory of monopoly tells us that sellers will always locate along elastic portions of demand curves, the demand for originals will necessarily increase when copying becomes possible if the only cost of copying is the copy's share of the cost of the original.

When we compute the price that the seller will charge facing the new demand curve, it turns out to be higher than when copying is not allowed. While quantity sold may rise or fall, the profits of the sellers of originals will <u>rise</u> when copying is allowed under the assumptions made above about the nature of copying. While some readers may be surprised to find that the profits of sellers can rise when copying is allowed, consider the case of computer software sellers some of whom sell their software in non-copy

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[6] That is because the demand elasticity relates the response of quantity demanded to the change in price. Along a demand curve with unitary elasticity, revenue, pQ, remains constant regardless of price. If price falls to one n^{th} of its previous value, quantity demanded will rise to n times its previous value. If elasticity is greater than one, quantity demanded will rise more than n-fold.

protected form. These sellers must feel that their profits are higher if they allow buyers to copy than if they do not.

Cost of Copying is a Fixed Cost plus Share of Price of Originals

A slightly more complex situation arises when the cost of copying includes a fixed cost (say the time involved in making a copy) as well as the share of the purchase price of an original. Let us suppose that the fixed cost of copying, call it w, is the same for everyone. Then, if an original can be used to make n copies, the cost of a copy will be $w + p_o/n$. How does this copy technology affect the demand for originals ? Now copying is undertaken only if it is cheaper than buying the original so for $p_o < w + p_o/n$, original demand remains the same as it was before copying (since at that price no-one copies). For prices above $nw/(n - 1)$, the demand curve is shifted in much the same way as in the simpler case above. At high prices demand is increased while at lower prices demand is reduced. Figure 3 shows how the demand for originals is affected by this kind of copying possibility.

What does copying do to the price of originals ? With these assumptions, we cannot say for sure whether prices will rise or fall; sellers may reduce the price low enough to foreclose copying or may raise prices to take advantage of the willingness of consumers to pay very high prices for a small quantity of originals to be used for copying.[7] Sellers' profits may either

[7] The possibility of either a high price or low price equilibrium is seen in many markets. In the prerecorded video cassette market, sellers either pursue a low price strategy for blockbuster films which consumers are likely to want to own, or a high price strategy to capture the rental demand for non-blockbuster films. Here video rental is a bit like copying since it allows many different households to view the film from one prerecorded cassette. Another example arises in the scholarly journal market in which subscription rates are high for libraries, where copying is likely to be common, and low for individuals, whose journals are not likely to be used for extensive copying.

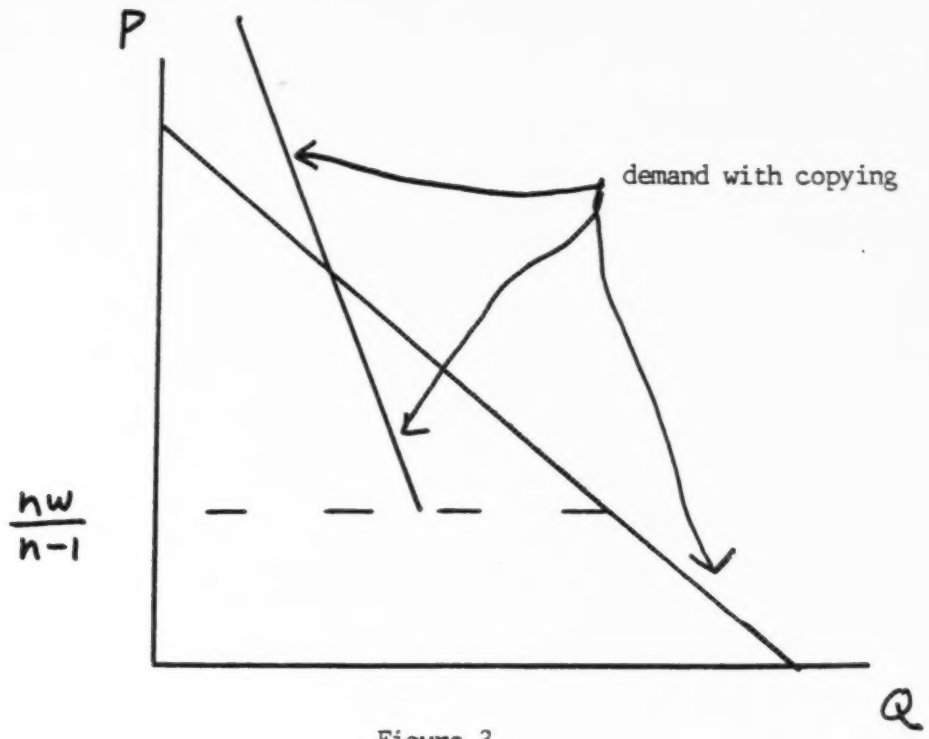

Figure 3

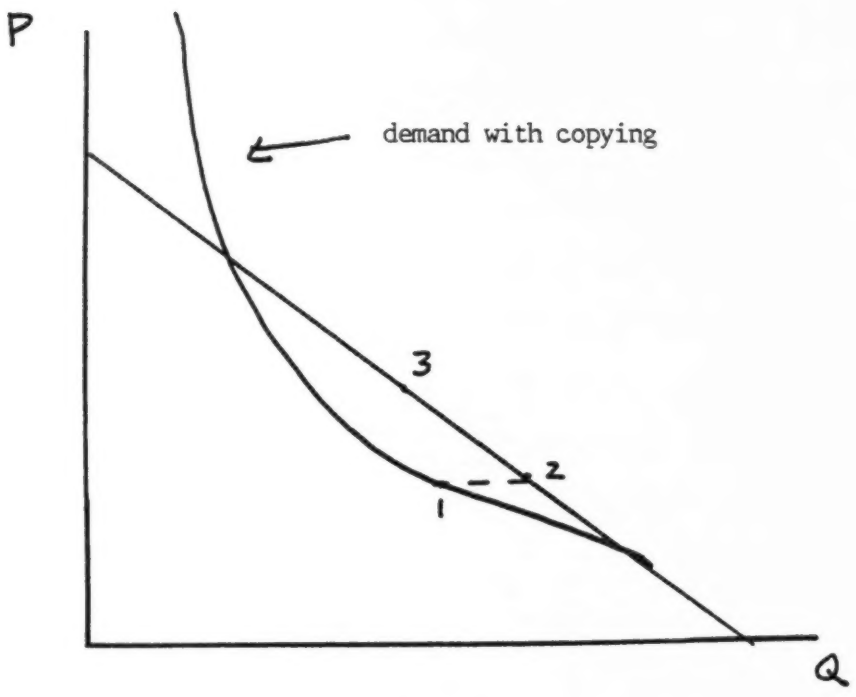

Figure 4

fall or rise depending on the specific demand function, the cost of copying, and the marginal cost of producing an original.

An even more realistic view of copying would see the cost of copying as a share of the cost of originals plus a fixed cost which varies across consumers. For example, the time costs of copying may differ across consumers. This view of copying explains why some consumers copy and others do not. The effect of copying on the demand curve for originals is depicted in Figure 4. Demand is increased at high prices of originals because of the induced demand from copying; demand is decreased at middle price ranges because of substitution; and demand is unchanged at low prices since copying is not economical when originals can be purchased for less than the cost of copying. Again, the effect of copying on prices, profits and quantity sold cannot be determined without much more specific assumptions about demand and costs. Hence we cannot say for sure that copying hurts sellers of originals.

III. Estimating the Effect of Copying

Since we live in a world with copying, to estimate the effect of copying on the producers of originals, we must predict the hypothetical demand for originals in the absence of the ability to copy. In Figure 4, point 1 represents observed sales of originals when copying is allowed, while point 3 is the hypothetical sale of originals that would be observed in a world with no copying. To estimate the effect of copying, we want to compare revenues (and profits) at these two points. There are two components to the difference between points 1 and 3. First, holding the price of originals constant, the shift to the no-copy demand curve changes the demand for originals (as in point 2). Second, if the firm faced the no-copy demand curve, then it would likely charge a different price (either higher or lower) for originals.

Omitting this second effect (the difference between point 2 and point 3) always leads to an understatement of the loss (or an overstatement of the gain) to the seller of originals caused by copying.

The first effect (point 1 to point 2) can be predicted from the response of original demand to the cost of copying. This allows estimation of the sum of the positive effects and the negative effects of copying on the demand for originals, holding the price of originals constant. Given the difficulty of estimating the price effect, this will yield an understatement of the losses due to copying.

An individual's demand for originals, Q_o, depends on the price of originals, p_o; the full cost of copying (including time cost), p_c; other observable characteristics of the demander, denoted by the vector Y; and an unobservable error, ϵ.

$$(4) \qquad Q_o = f(p_o, p_c, Y, \epsilon)$$

In equation (4), p_o is constant across the population but p_c, Y, and ϵ are not. The idiosyncratic cost of copying, p_c depends on the value of the copier's time, the ease of access to originals to copy, etc. I interpret (4) as a long-run demand curve, so variations in the stock of copying equipment owned by the consumer should not appear in (4) because that is endogenous in the long run. Figure 5 shows an example of equation (4) graphed with Q_o and p_c as the axes. I have drawn the demand to be upward-sloping in the price of copying, implying that negative effect of copying dominates the positive effects but the empirical analysis need not assume this. As the price of copying gets higher, the effect on the demand for originals should attenuate; eventually copying becomes so expensive that no-one undertakes it. The demand for originals at that high cost of copying is the predicted demand for originals in the absence of copying.

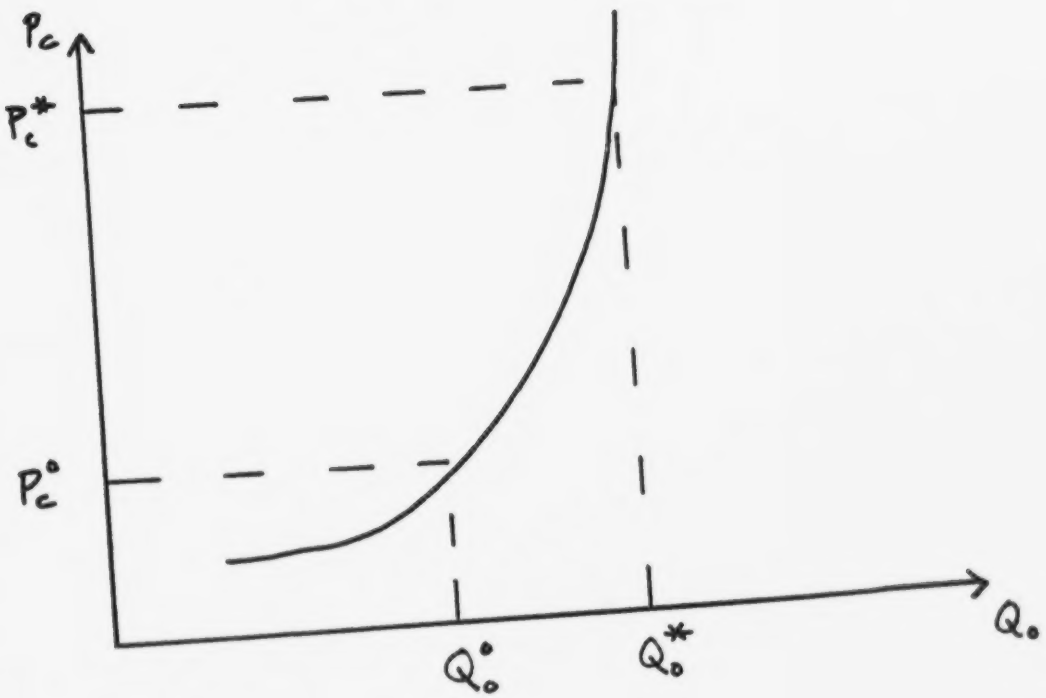

Figure 5

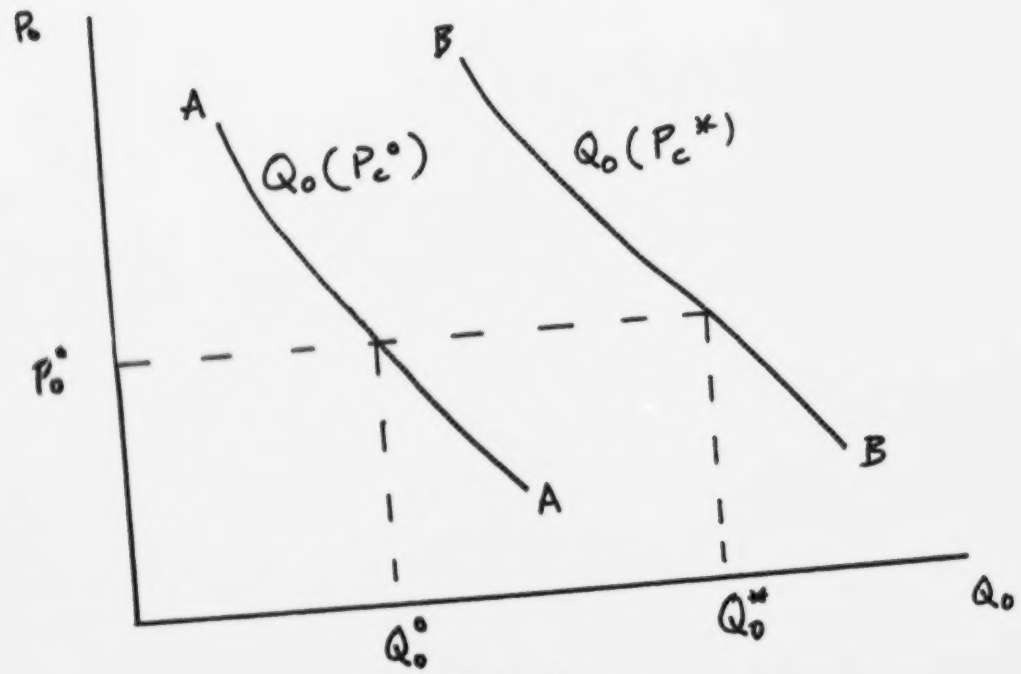

Figure 6

The market demand for originals is the sum of the demands by all individuals, and so depends on the price of originals, p_o, the vector of all individuals' copying costs, the vector of all individuals' observed characteristics, and the vector of all individuals' unobserved characteristics. Call the observed vector of copying costs, p_c^o, and the observed price of originals, p_o^o. Then, curve AA in Figure 6 depicts the demand for originals as a function of p_o, for the observed vector of copying costs, p_c^o. The observed quantity of originals sold, Q_o^o, is the point on that curve where $p_o = p_o^o$, the observed price of originals. Revenues to the producers of originals are depicted by the rectangle formed by p_o^o and Q_o^o.

The effect of no copying is captured by a rise in each person's p_c sufficient to squelch copying; this price is denoted by p_c^* on Figure 5. If copies are exactly equivalent to originals then $p_c^* = p_o$, but if copies are considered superior to originals then $p_c^* > p_o$, implying that consumers will copy even if copies cost more than originals. By relating the data on copying to the price of copying we can estimate p_c^* directly. Curve BB in Figure 6 shows the market demand for originals when the vector of prices of copying is p_c^*, or when there is no copying. Holding the price of originals constant at p_o^o, the demand for originals would be Q_o^* if there were no copying. We can estimate Q_o^* by estimating the demand for originals by each consumer if p_c were p_c^*. Then, lost revenue would be $p_o^o \cdot [\, Q_o^* - Q_o^o \,]$. Again, this estimate of lost revenue neglects the price effect, by which the price of originals will change when copying is forbidden, and hence understates the lost revenue due to copying.

To summarize, demand curve (5) can be estimated using data on individual characteristics, the idiosyncratic cost of copying and the purchase of originals. The demand for originals with no copying is estimated by inserting

$p^*_{c,}$, the price of copying which chokes off copy demand, into the demand for originals. Estimates of p^*_c can come from estimates of the demand for copying as a function of the cost of copying. The crucial data needed are:

a) quantities of copying and purchases of originals

b) the idiosyncratic cost of copying, either the time it takes to copy times the wage rate plus the cost of blank media, or the amount the person is willing to pay to have someone make a copy for him.

c) other individual characteristics relevant to the demand for original and copies.

IV. Conclusion

In theory, copying may either raise or lower the price of originals and the profits of the sellers of originals. A positive effect of copying on the demand for originals is more likely the more elastic is the demand curve and the more important is the amortized cost of the original in the total cost of copying. In some markets, small differences in costs or demand can make a big difference in equilibrium price. In the high price strategy, originals are priced to reflect their value as sources of copies; sellers expect consumers to copy. In the low price equilibrium, originals are priced to make copying unattractive compared with buying an original.

To estimate empirically the effect of copying, we need to know both how demand would differ at current prices and how the price would be changed. The first effect might be estimated by looking at differences across consumers in copying behavior; if copying takes time, then consumers with a high value of time will be less likely to copy. The relation between the cost of copying and purchases of originals across the population will allow one to trace the

effect of banning copying (i.e., making it more expensive) on the demand for originals. This, in turn, allows us to compute how much copying has changed the demand for originals at current prices but does not allow us to say anything about how prices of originals would differ were there no copying.

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